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ABSTRACT

A comprehensive examination of the psychological and biological factors involved in exercise addiction is presented in an attempt to explain the varying position of individuals on the continuum of ability to commence and continue a regimen of physical activity. Physiclogical considerations in exercise tolerance and the feelings derived from exercising are discussed. The psycho-social perspective is examined with consideration given to a number of theoretical orientations in this area, including Freud's drive reduction theory, Petrie's augmentation-reduction model, Eysenck's research on extraversion-introversion and the opponent-process theory of motivation, theories primarily relating to the phenomenon of exercise addiction. Psycho-biological mechanisms are identified which encourage a high frequency of participation in physical acitivity such that participants are considered to be habituated.
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Hooked on Exercise:

A Psycho-biological Explanation

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"Stick-to-it-iveness" has always been an honored American ethic. Perhaps our glorification of self-discipline and the ability to "hang in" are throwbacks to Puritan days, when offspring of austere, serious minded zealots were instructed in the nobility of continued hard work, unfaltering will and the virtue of completing tasks begun. To large measure, these values have withstood the well known ravishments of time, and today, some 300 years beyond the day of the Puritan, their impact upon various American practices is felt. We continue to be restrained and restricted in many of our attempted social, educational and medical advances by the renowned Puritan heritage. Indeed, we have permitted this legacy to be indelibly imposed upon our collective American sub-conscious.

But in all fairness to those grave purveyors of the Gospel, certain of their bequeathed values are admittedly very resistant to ridicule or debasement. Honesty is indeed a human attribute which deserves reinforcement across all areas of society. Task completion is emphasized and reinforced by athletic coaches, teachers and professors, as an absolutely vital attribute for the athlete as well as the scholar to possess. In fact, "hanging in" is often the quality which tips the balance in favor of the doctoral student who prevails, in contrast to the one who doesn't succeed. A propensity for "grinning and bearing it," is undeniably a desirable quality in many human endeavors and probably both genetic as well as social learning bases underlie its existence and development. Individual biological characteristics such as sensory-perceptual strengths and neuroanatomical factors most likely interact with motivational and situational dynamics to account for differential abilities in self-discipline, "hanging in," and finishing the job.

The Puritan patriarchs would be nonplused to learn of the endeared status with which these attributes are considered in today's world of sport. In fact their surprise would spring initially from the very notion of a "world of sport," for play and recreational activities without utilitarian foundation was inconceivable to our forefathers. If it were within their conceptual horizon, it undoubtedly would have been considered anathema.

Whether the prevailing learning and performing environment for athletes is humanistic, authoritarian, explorative-discovery, or equalitarian, "staying with it"; "not quitting" in the face of travail; "guts" or fortitude; and appearing regularly for practice, scrimmage and play, are all very highly valued. The motor learning literature insists that rehearsal (trial by trial repetition of tasks) is critical to proficient skill development. The exercise physiology literature points unequivocally to the need for regular, sustained and fairly vigorous physical activity in order that cardiorespiratory gains be made. Thus, our academic instincts compel us to accept task completion and regularity of participation as essential ingredients of human, motor performance (e.g., sport) success. Of course the doses of repetition, and schedules for attendance are variables which the coach, individual athlete and researcher alike, manipulate in efforts to identify the optimum requirement for each. But both the psychologist who studies sport, and the sportsperson who attempts to apply psychological principles, have known for some time that sweeping prescriptions of physical activity should not be assigned to all competitors on a team; all athletes in a training camp; all members of a physical education class, or for that matter, all clients exercising in a commercial health club. Psycho-biological abilities for completing tasks, appearing for training and maintaining attendance in programs of physical activity are variable within groups

even if we control for level of physiological preparedness for activity (i.e., fitness).

What is the nature of this variability? How is it that individuals differ in their position on the continuum of "hanging-in," and differ in their ability to continue a regimen of physical activity? How is it that certain participants in gross motor physical activity never miss a workout while others attend sporadically? This paper addresses such questions, but by no means does it relate exclusively to the athlete. Its implications are for those who participate with a high degree of regularity in physical activity and of course this also includes the athlete person as he/she is typically envisioned. Of specific concern is clarification of psycho-biological mechanisms which encourage a very high frequency of participation in physical activity so that participants are considered to be habituated.

In effect, this paper is divided into two main parts: one dealing with psychological and the other with biological theory. Although separation of these two is probably indefensible when considering human behavior, it is organizationally best to treat notions which attempt to explain exercise dependence in two such separate categories (not withstanding the well respected organismic approach to studying and understanding human behavioral response).

The literature dealing with drug addiction provides a considerable amount of insight into exercise dependence. Many of the assertions about factors contributing to physiologic addiction to chemical agents are also applicable to physical activity. Although the fundamental dependence paradigms involving tolerance and withdrawal are very similar in both instances, some differences are to be noted. Even addiction to various chemical agents produces differential effects, behavioral as well as organic (Heroin addiction is different from LSD addiction in

many ways (Torda, 1968)). Let us first turn to some of the physiological considerations as we acknowledge the biological aspect of the "psycho-biological approach" included in the title of this paper. But frankly, this treatment is very superficial for it is the psychological implications of exercise dependence that are paramount in this presentation.

Physiological considerations

Tolerance involves an adaptive process of the body to some substances to which it is regularly exposed. It is well known that vigorous physical activity produces within the body a number of biochemical and physiological adaptations (Guyton, 1971; Karpovich & Sinning, 1971). Exercise dependence will probably not arise unless a person consistently exercises at an intensity which produces the normal biochemical reactions indicative of a fair amount of physical stress. Glasser (1976) insists that at least an hour a day is necessary in order that addiction in runners occur. Frequent repetitive exposure to this total physiological activation will then produce adaptation and tolerance. If exercise, like drug use, is discontinued, tolerance decreases over time. If exercise is later renewed, less can be tolerated and less is required to produce the original effect (i.e., fatigue).

Immediate effects of exercise may include an elevated respiratory rate, faster heart rate, and higher blood pressure. Long-term effects may include a more efficient cardiovascular system, greater endurance, stronger muscles, and a trimmer waistline. These training effects vary according to the type of exercise, its frequency, intensity, and duration. They are also affected by the original fitness level of the participant and his age. The training effect also implies development of a tolerance

for exercise, and after training it takes a heavier dose of exercise to produce fatigue. Cooper (1970) describes how such a training effect may be achieved through participation in an exercise program. Although such training does not produce exercise dependence, it very well may lay the groundwork for its development.

Regular exercisers maintain that they "feel better" as a result of their physical activity. This effect is commonly referred to as "catharsis" and may be noted after using large areas of the neuromuscular system. It seems to arise through psycho-physiological changes and adjustments concurrent with physical activity (Harris, 1973). On a long term basis, the "feel better" response is undoubtedly related to an improved level of fitness and greater physiological reserves which result from daily exercise. Thus, an individual may accomplish more work with less accompanying fatigue but still have energy to spare. Instead of being in a state of passive health which usually means "not ill," the exerciser has reached a state of dynamic health, improving the function of many body systems. Exercisers report that a good workout is invigorating and refreshing. It relieves tension, produces relaxation and even improves sleep (Bakeland & Lasky, 1966; Gary & Guthrie, 1972; Graham, 1966).

It seems that people may become dependent on exercise for the improved sense of physical well-being that it brings. There is evidence that when deprived of this experience, addicted exercisers feel "less well." Withdrawal symptoms of increased anxiety, restlessness, increased sexual tension, and impaired sleep were reported by 14 moderate exercisers who were deprived of their accustomed activity for a month (Bakeland, 1970). Although these men exercised only three to four times per week, this was sufficient to produce dependence on exercise and what they termed, a "hardship" in having to do without it. Bakeland

(1970) attempted to recruit men from his study who exercised daily, but was unable to obtain volunteers from this group, even though they would be paid to do without exercise. Some asserted that they would not stop exercising for any amount of money. For them, the anticipated difficulty of doing without daily exercise was too much to endure for as long as a month.

A study conducted by Hanson (1964) has indicated that lower order animals may also become exercise dependent. A group of rats was forced to exercise daily for 35 days, comparable to three years of a human life-span. When given the choice of being sedentary or exercisers, these rats continued to voluntarily exercise more often and more intensely than controls.

The psycho-social perspective

It appears that for many individuals, regular vigorous physical activity is a necessity. Without it a general uncomfortableness and feeling of deprivation and disappointment prevails. As previously mentioned, hard core, committed exercisers are reported to be very resistant to relinquishing opportunities for regular exercise even when encouraged with monetary remuneration. Brunner (1969) and McPherson, Paivio, Yuhasz, Rechnitzer, Pickard and Lefcoe (1965) have reported that in their subjects the feeling of well being accompanying participation in an exercise program is a strong motivator for continued participation in physical activity. In these persons regular physical activity is apparently needed for their sense of confort. Glasser (1975) refers to the need for regular exercise as a "positive addiction" and Abell (1975) calls it a "compulsion." This symptomatology has also been described by other authors (Cooper, 1970; Graham, 1966). Glasser (1976), in his book Positive Addiction, refers to the "high" or euphoria ex-

perienced by the seasoned distance jogger or runner. To a considerable extent Glasser's conclusions rely upon anecdotal support and are therefore probably not granted the scientific acceptance to which reports having meticulously regulated experimental procedures, or carefully implemented descriptive or comparative components, are entitled. Scholars in the sport psychology field typically eschew clinical, psychiatric reports and favor designs which operationalize and test theories. This may be due in part, to our typical social psychological or motor learning professional preparation and proclivities. At any rate, Glasser claims to have interacted personally or through the mails with hundreds of "addicted" runners who describe a transcendence of ordinary consciousness through physical exercise. They report a magnificent "high" which enables them to temporarily, although not regularly, exist externally to themselves. They are alleged to metaphorically leave their bodies and somehow float in an existential ambiance of wonder and magnificence. They are newborn; they are figuratively beside themselves, and they are free. These are essentially endurance type performers - joggers, runners, and probably also swimmers and cyclists, but not bowlers, golfers or baseball players. However, Glasser does not necessarily exclude such exercise participants from those who can experience the Positive Addiction (PA) state and I suspect that he would argue that all exercise addicts, table tennis, archery, sit-up and push-up freaks included, are equal in their vulnerability to this temporary condition. How so? - Why?

Freud's drive reduction theory provides a gross and basic clarification of this question, but it is insufficient as an absolute explanation. However, others (Duffy, 1957; Ellis, 1973; Fiske and Maddi, 1961; Hebb and Thompson, 1954; Leuba, 1955; Zuckerman, Bone, Neary,

Mangelsdorff & Brustman, 1972) incorporate Freud's drive reduction theory in their conceptualization of a continuum of arousal. These authors suggest a spectrum of activation ranging from deep sleep to extreme effort or great excitement. Somewhere between these two extremes is an optimal range of excitement for which an individual is best suited. There also exists a desirable level of stimulus-input which accounts for optimal arousal. Furthermore, an individual learns to react in a manner which tends to maintain optimal arousal by increasing or decreasing stimulation. One acquires an understanding of the kinds of activities needed, thereby rejecting some and pursuing others. Thus, boredom or overstimulation are avoided through behaviors (stimulus seeking and stimulus avoidance) which tend to maintain satisfactory arousal.

But the Freudian explanation does not address underlying neural mechanisms and integrative processes which we may assume are operational. It is insufficient to conclude that an individual simply learns through previous experience which activities are best suited to his most effective activation range. Let us therefore briefly overview a few neurological considerations and in a manner of speaking, upgrade the optimal level of arousal explanation.

We know that the effects of arousal are mediated by anterior, superior aspects of the reticular formation (the reticular activating system, RAS), which exerts an excitatory influence upon the organism's behavior. The RAS is subject to an extremely wide variety of afferent impulses (e.g. touch, pain, temperature changes, olfactory and auditory impulses, hormonal and chemical changes, drugs). In brief, this part of the reticular formation exerts a vital control of the level of attention to sensory stimuli. On the other hand, inhibitory mechanisms also find expression through the posterior, inferior part of the reticular formation as well as through various cortical functions. Other counterbalancing

efforts (antagonistic to the excitatory influence of the RAS) are mediated by medullary function. Synaptic fatigue may also play a role in antagonizing RAS influence. Therefore, for each of us, arousal or excitation may be defined as a balance between RAS and cortical activity. The work of Duffy (1957) suggests that variations in the degree of arousal may affect the quality of motor response (Inverted-U Model). But within the theorized optimal range of arousal, an individual is expected to function most effectively. Therefore, humans are highly motivated and indeed driven toward seeking optimal levels of arousal. Slight deviations in one direction from the desired range in the arousal continuum produce sensations of pleasure and changes in the opposite direction are aversive or unpleasant. Schultz (1967) reported that in his subjects, arousal states which were apparently not optimal resulted in behavior aimed at adjusting the degree of activation. Simply stated, one who is not optimally stimulated will seek to interact with the environment in such a way as to encourage cortical and RAS activity, which in turn will produce a desired arousal level.

Ironically, a level of arousal which is too low for an individual may cause irritability which is aversive to the point that the organism experiences excitation or increased arousal. Thus, Berlyne (1960) was motivated to speculate that a very low level of activation may actually result in reduced cortical inhibition of the RAS and subsequently produce a stimulating effect. Perhaps this mechanism underlies the feeling of increased need to exercise which habitual exercisers report after being restricted to a low stimulating environment for a relatively long period of time. (The feeling that we must get away from the desk and on to the track.)

Ellis (1973) says that humans in particular tend towards being sub-optimally aroused because of a large information processing capability.

Man therefore, is in constant quest of experiences which will excite him, since the arousing potential of the same stimuli decreases with each repetition. That is to say, the same stimuli do not repeatedly produce arousal to the same degree. Perhaps this is one reason for the jogger's interest in cutting down his time, increasing the jogging distance or varying the jogging course.

Pearson (1970) suggests that various modalities operate within humans to satisfy increased stimulus needs. He describes two basic models: an active form and a passive form. Active forms may be further categorized into those which rely upon tangible external events and those which rely upon internal events such as daydreams and feelings. The objective of both active and passive approaches is the production of novel experiences which arouse. The passive form of stimulus seeking behavior involves the perception of novelty which is not internally fostered (i.e., visually appreciating an occurring event, integrating it perceptually and permitting it to arouse, as opposed to intellectually generating or fantasizing an image in order to cause activation).

Petrie's augmentation-reduction model (with which this audience is undoubtedly familiar) describes the reducer as one who benefits from the intense stimulus of physical activity. The well known work of Ryan (1969) appears to support Petrie's theory. Ryan observed that contact sport athletes possess characteristics of the reducer, and a group of subjects which expressed a dislike for participation in athletics demonstrated augmentor characteristics. Noncontact sport athletes were found to be located between the extremes of reducer-augmentor. Reducers are apparently gratified by more vigorous and stressful activities in contrast to the more sedentary experiences sought by augmentors. Although application of Petrie's theory to the topic at hand (dependence upon, or habituation to, regular physical activity) is very speculative. It is

appropriate to include her construct within this review of related materials, in that it deals with mediation of stimulation strength.

Kane (1971) brings Petrie's theory into juxtaposition with the Eysenckian notion of Extraversion - Introversion and suggests that the reducer and extravert are analagous types and that the augmentor and introvert are alike. Eysenck postulated that extraverts are more stimulus-hungry than introverts and support for this hypothesis has come from studies showing that extraverts are less able to tolerate sensory and perceptual deprivation (Francis, 1969; Gale, 1969; Miyashiro & Russell, 1974). Also, extraverts demonstrate stronger sensation-seeking tendencies than introverts (Bone and Montgomery, 1970; Farley and Farley, 1967; Ludvigh, 1972; Philipp & Wilde, 1970; Zuckerman et al., 1972). Recently, in one of our studies at Florida State University, we observed a positive correlation between extraversion and stimulus-seeking in 90 male subjects who exercised with varying degrees of regularity (Burgess and Pergman, 1977). However, we were unable to report, as hypothesized, that those identified as "Exercise dependent" scored higher on the extraversion scale than "regular" exercisers. It may be that our definitions of "exercise dependent subject" and "occasional exerciser" did not adequately discriminate between the two kinds of subjects.

Individuals also differ in the degree of arousal obtained under similar and even identical stimulation. In the same situation, one person may become highly aroused and another only moderately activated. While the degree of arousal varies with the situation, the rank in arousal as compared to other individuals tends to remain the same. An individual who responds intensely in one situation will usually respond comparably in other situations, in relation to other individuals (Duffy, 1957; Klavora, 1975).

What is necessary are reliable tests of the hypothesis that an individual's response to arousing stimuli remains fairly consistent throughout the chronological continuum. If this hypothesis were true, then important implications exist for older or former athletes, as well as for young but injured and rejected athletes. Furthermore, if human response to stimuli is relatively invariable over time, then the so called "catharsis" rationale for physical activity which the writings of Bakeland (1970), Cooper (1970), Graham (1966) and Steinbach (1965) support, is strengthened.

Data published by Ismail and Trachtman (1973) suggest that regular participation by middle aged men in a jogging program over a three month period increased emotional stability and guilt proneness (among other things). Glasser (1976) attempts to explain the increased guilt proneness in terms of positive addiction. According to Glasser, when participants in the program realized that it was over, they quit. The encounter with the positive addiction state during the three months provided participants with a sense that they had partaken of an extremely unusual and valuable experience. Now that it had concluded, they developed guilt about abandoning this salubrious, mind spinning opportunity. Their guilt was exacerbated by their realization of the small likelihood of continuing with the exercise program, since continuation was contingent upon their own internal motivation. The group under the supervision of the researchers had been disbanded and although participants were not truly addicted, their anticipation of the end of a very pleasurable experience prompted increased guilt.

Changes in state or trait personality attributes allegedly caused by participation in a program of regular, vigorous physical activity have been described by Massie and Shepard (1971) and Cary and Guthrie (1972). Also, Morgan, Roberts, Brand and Feinerman (1970) have observed

significant reduction in depression in psychiatrically depressed males after six weeks of regular physical activity. Harris, (1973) also characterizes the psychology of the exercise-dependent individual as being self-disciplined, hardworking, achievement oriented, extraverted, emotionally stable, self-assured and nonanxious.

The last of the psychological considerations discussed here which are speculated to bear upon exercise dependence, is the opponent-process theory of motivation proposed by Solomon & Corbit (1973, 1974). It is one of many constructs referred to as "derived motives" (D'Arato, 1974). This model is based upon a concept of motivational homeostasis which has been in circulation for some time, and posits that motivation is acquired. In effect, the opponent-process theory says that the mechanisms striving to restore hedonic balance to an out of kilter system, may generate an affect which is quite the opposite of what was intended (hence the term, "opponent"). The opponent-process needs time to be effectuated and so there occurs a delayed implementation of this second order affect. However, in time, it gains in strength and ultimately dominates the object of the initial stimulus input. For it to be well established, numerous elicitations of the affect must occur.

To use an illustration offered by Solomon & Corbit (1973), parachutists seemed to be "stunned" after experiencing their first few leaps from the moving airplane. They are quite fearful and terrified before jumping, but after a number of trials, during which time the "opponent" gains in potency, the fear and terror give way to feelings of exhilaration and euphoria. Subsequent jumps continue to enforce the positive feelings and ultimately the jump is associated with very positive and joyful emotion. Increased frequency of the first state enforces the strength of the second. The model is potentially applicable to both positive and negative affect states, and therein lies its relevance to

Glasser's positive addiction (1976) and to the entire issue of exercise dependence. Accordingly, the "hooked" or dependent exerciser endures the discomfort or even pain of the demanding physical experience (in this case, the negative affect) in order to arrive at the pleasure and jubilance of the feeling produced at its termination. The exerciser volitionally and perhaps masochistically initiates an aversive primary condition in order to achieve the joy and pleasure of the secondary state. Thus the so called hedonic balance is restored by proceeding from a relatively aversive condition to one which produces pleasure or euphoria. In brief, the exercise addict is not habituated to running, swimming, or an exhausting calisthenic regimen, but to the pleasure provided by its cessation and the restoration of the equilibrium which is displaced during its occurrence. Perhaps the opponent-process model is a much needed theoretical explanation which seems to be absent from Glasser's concept of positive addiction.

A relative dearth of interest, information and application of theory dealing with exercise dependence exists. Motor and athletic educators appear to be concerned with individuals who cannot be motivated to attend classes, team practice or training sessions. Sedentary persons who begin programs of regular exercise are often studied and some attention has been given to participants in fitness programs who have dropped out. There are some detraining studies in the literature (done mostly by physiologists). But it is also important to study exercise dependent persons and this has really not been done in any organized manner. Former athletes who are obliged to curtail physical activity, and young athletes unable to train with necessary regularity, are examples of subjects who should be studied. In addition, information and hypotheses are needed which attempt to clarify the psychology of injured athletes and "demoted" athletes who must endure extended lay-off periods.

Summary

In this paper we have addressed the typically ignored individual who is motivated to participate in vigorous physical activity with stubborn regularity. But in reality we have been talking about the channel swimmer, the marathon runner, and the decathlon athlete, because these sportspersons cannot even complete their events without months of regular, and difficult training. However we have also considered the untold number of individuals who doggedly jog or swim everyday without caring a fig for competition. But somehow they are driven to their daily workouts by forces which they do not entirely understand. In an attempt to clarify their motivation for regular, sustained physical activity, we have discussed in varying detail, Freud's drive reduction theory; optimal arousal theory; active and passive forms of stimulus seeking; Petrie's augmentation-reduction model; the Eysenckian concept of extraversion and introversion; Glasser's positive addiction theory; the notion of physical exercise serving as an opportunity for "catharsis"; personality as affected by regimens of regular physical activity; and the opponent-process of derived motivation. Some physiological considerations have also been made.

Dr. George Sheehan, the prolific cardiologist whose writings about running appear in numerous periodicals and journals as well as in his own book, Dr. Sheehan on Running, portrays the dependent runner as a very unusual and somewhat frightening individual. His description is appropriate to review as this paper concludes, in that the runner perhaps epitomizes the exercise addict. The runner is the archetype of the "hooked" on exercise individual. Dr. Sheehan writes,

> The runner does not run because he is too slight for football or hasn't the ability to put a ball through

a hoop, or can't hit a curveball. He doesn't run to lose weight or become fit, or to prevent heart attacks. He runs because he has to. Because in being a runner, in moving through pain and fatigue and suffering, in imposing stress; in eliminating all but the necessities of life, he is fulfilling himself and becoming the person he is.

In this surrender, the runner does not deny his body. He does not subdue it, or subjugate it, or mortify it. He perfects it, maximizes it, magnifies it.

Whatever I give up, whatever innocent indulgence, ordinary pleasures or extraordinary vices, I do so from some inner compulsion, not in a mood of self-sacrifice or from sense of duty. I am simply doing what comes naturally.

Whether or not we are able to project those we know, those we teach and coach or even ourselves to Sheehan's stereotype, we must recognize that such persons exist and it is our responsibility to play upon them the searchlight of scientific inquiry. They deserve to be studied.

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